Thermal Transistor for Energy Smart Buildings

Los Alamos NATIONAL LABORATORY EST. 1943

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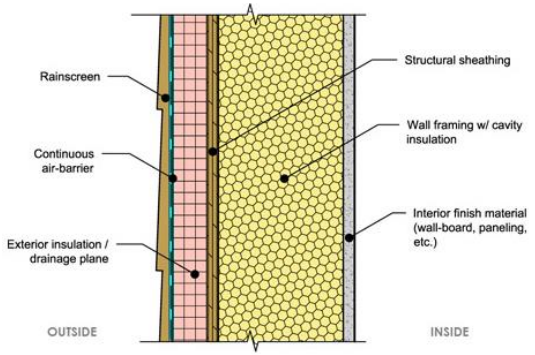
Thin-film heat switch creates thermally active walls to enable energy-efficient buildings

LDRD innovation for our nation

BACKGROUND & MOTIVATION

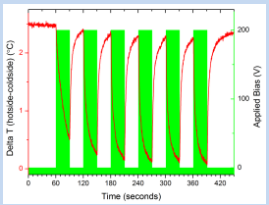
The thermal properties of building walls are fixed by design

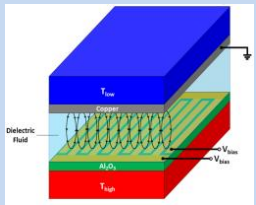


- They cannot adapt to daily or seasonal temperature variations
- These shortcomings require inefficient heating / cooling of inside air

INNOVATION

LANL Innovation: Thermal Transistor





Thin-film device that can change its thermal conductivity by >50 fold:

- Made from non-toxic low-cost materials that are commercially available
- Low power consumption: ~0.5 W/sq.ft.
- Insulating: 0.06 W/K·m (fleece fabric)
- Conducting: >3 W/K·m (near metal)

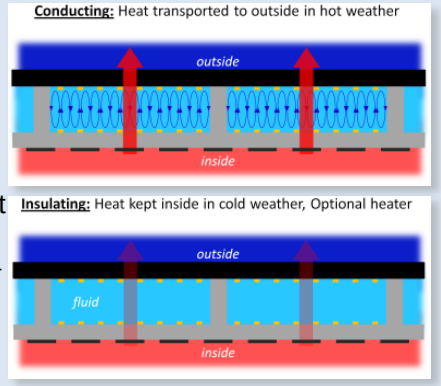
DESCRIPTION

Concept: Thermally active building walls

- Add a thermal transistors to building walls to enable agile heat management
- Realize significant cost savings and reduction of greenhouse gases
- Thermal transistors fabricated in the form of large sheets that are integrated with conventional construction materials.
- System enables a building that can adapt to thermal changes in the environment by exploiting natural temperature gradients

How it works:

- Applying a voltage to the control electrodes induces motion in the fluid and allows for efficient heat transport by convection. The fluid is static without a voltage and only minimally conducts heat.



Assumptions & Limitations:

- Current LANL prototype: ~50 cm^2 active area. Assume it can be scaled to sq.ft size relevant for applications
- Switching requires ~200 Volts but only draws a few µA. The associated drive electronics comprises only off-the-shelf components.

Current Technology Readiness Level (TRL) 4

- Individual components have been tested and a system level prototype has been tested and integrated in the lab

ANTICIPATED IMPACT

Thermally adaptive devices and systems may be a game changer in energy efficiency, buildings and beyond:

- Thermally agile walls can enable significant cost savings and reduce greenhouse gases (high volume market)
- Potential for flexible format that could be used in thermally active clothing (high volume market)
- Thermal transistors can find applications in the thermal management of high-performance computers
- LANL is currently developing thermal transistor technology for application on satellite platforms

PATH FORWARD

Demonstrate thermal transistor tile with 1 sq.ft. area:

- Quantitative thermal and electrical characterization
- Tested under applicable environmental conditions
- IP protected and industrial partner identified.
- Cost model for mass production

Potential End Users:

- Construction companies (commercial and residential)

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